

**SYSTEMS AND METHODS FOR PROVIDING
HAPTIC EFFECTS IN RESPONSE TO
DEFORMATION OF A COVER FOR AN
ELECTRONIC DEVICE**

FIELD

[0001] The present invention is generally directed to systems and methods for providing haptic effects in response to deformation of a flexible cover for an electronic device.

BACKGROUND

[0002] Handheld electronic devices, such as smartphones, tablets, and e-book readers, are frequently used with covers that protect their screens and can be peeled off while in use. It is increasingly common for such devices to be able to detect the state of the cover and take an action based on the detected state. For example, many screen covers cause the display screen of the electronic device to turn off when the cover is closed. It is expected that covers for electronic devices will eventually be instrumented so that gestures, such as bending the cover or one of the corners of the cover, or peeling the cover off of the electronic device, can be detected and used for user input.

SUMMARY

[0003] It is desirable to improve a user's interactions with a cover of an electronic device by providing additional information to the user.

[0004] According to an aspect of the invention, there is provided a system that includes an electronic device comprising a display screen, a cover configured to cover the display screen, a sensor configured to sense an input gesture that includes deformation and/or movement of the cover relative to the electronic device, and a processor configured to determine an action for the electronic device to perform based on the input gesture, to determine a haptic effect to generate based on the input gesture and/or the action for the electronic device to perform, and to initiate the action. The system also includes a haptic output device configured to generate the haptic effect.

[0005] In an embodiment, the sensor is selected from the group consisting of: a bend sensor, a light sensor, a pressure sensor, a contact sensor, a potentiometer, an angular sensor, an angular velocity sensor, an accelerometer, and a magnetic sensor.

[0006] In an embodiment, the haptic output device includes an actuator configured to generate vibrations.

[0007] In an embodiment, the cover includes the actuator.

[0008] In an embodiment, the system includes a hinge that connects the cover to the electronic device, and the hinge includes the actuator.

[0009] In an embodiment, the haptic output device is embedded in the cover and includes an electro-rheological or magneto-rheological fluid to control a stiffness of the cover.

[0010] In an embodiment, the haptic output device includes an electrostatic friction device configured to generate a friction effect at a surface of the cover. In an embodiment, the surface of the cover faces the electronic device when the cover covers the display screen.

[0011] According to an aspect of the invention, there is provided a method that includes sensing an input gesture comprising deformation and/or movement of a cover for an

electronic device relative to the electronic device with a sensor, determining an action for the electronic device to perform based on the input gesture with a processor, determining a haptic effect to generate based on the input gesture and/or the action for the electronic device to perform with the processor, initiating the action for the electronic device to perform with the processor, and generating the haptic effect with a haptic output device during and/or after the sensing of the input gesture.

[0012] In an embodiment, the haptic effect is generated during the sensing of the input gesture.

[0013] In an embodiment, the haptic effect is generated after the sensing of the input gesture.

[0014] In an embodiment, the haptic effect is generated after the action is completed to confirm completion of the action.

[0015] In an embodiment, the haptic effect includes resisting peeling of the cover away from the electronic device.

[0016] In an embodiment, the haptic effect includes creating a texture when the cover is peeled away from the electronic device.

[0017] In an embodiment, the haptic effect includes changing a stiffness of the cover.

[0018] In an embodiment, the haptic effect includes a tactile sensation on a surface of the cover facing the electronic device when the cover covers the electronic device.

[0019] In an embodiment, the haptic effect includes a tactile sensation on a top surface of the cover opposite a surface facing the electronic device when the cover covers the electronic device.

[0020] In an embodiment, the method includes determining whether the action can be initiated, and the haptic effect includes resisting the deformation when the action cannot be initiated.

[0021] In an embodiment, the haptic effect includes actuating at least one hinge located along at least one crease in the cover to fold the cover at the crease.

[0022] In an embodiment, the haptic effect includes restricting movement of the cover to a predetermined angle relative to the electronic device based on the action.

[0023] According to an aspect of the invention, there is provided a cover for an electronic device. The cover includes a sensor configured to sense an input gesture comprising deformation and/or movement of the cover relative to the electronic device, and a haptic output device configured to generate a haptic effect based on the input gesture.

[0024] In an embodiment, the cover includes a processor configured to determine an action for the electronic device to perform based on the input gesture, to determine the haptic effect to generate based on the input gesture and/or the action for the electronic device to perform, and to initiate the action.

[0025] These and other aspects, features, and characteristics of the present invention, as well as the methods of operation and functions of the related elements of structure and the combination of parts and economies of manufacture, will become more apparent upon consideration of the following description and the appended claims with reference to the accompanying drawings, all of which form a part of this specification. It is to be expressly understood, however, that the drawings are for the purpose of illustration and description only and are not intended as a definition of the limits of the invention. As used in the specification and in the